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INTERNATIONAL PERSPECTIVES ON ECDIS

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INTRODUCTION

This paper is being written after the adoption of the Performance Standards for ECDIS but before the Second Meeting of the IHO Committee on WEND (Worldwide Electronic Navigational Chart Database). It therefore marks a moment in the evolution of ECDIS between the development of specifications and the development of the database that is so essential for its operation. Although the Performance Standard has been approved, through the adoption of the International Maritime Organization's (IMO) Resolution A/817 by the Assembly, there remain many loose ends to pick up and complete before manufacturers and type approval organizations will know exactly what is expected of them. The first part of this paper will discuss those matters. The second part of the paper will discuss what is being done and what is believed must be done, to produce a worldwide database service of Electronic Navigational Chart (ENC) data that will satisfy the future needs of international shipping. It will also discuss the interim and alternative approaches that are being proposed or considered.

PERFORMANCE STANDARDS

It was a major step forward in the evolution of ECDIS when the Assembly of the IMO approved the covering resolution for the Performance Standards in November 1995. This culminated the work of the IMO/IHO Harmonizing Group on ECDIS, which had started in 1987. Numerous individuals and organizations had contributed to drafting these specifications but two organizations in particular, have contributed detailed specifications, which are referred to by the IMO Performance Standards. These are the International Hydrographic Organization (IHO) and the International Electrotechnical Commission (IEC). The specifications prepared by these two organizations provide the details, without which it would not be possible for manufacturers to develop the equipment. The IHO, working through its

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Committee on ECDIS, its Committee on the Exchange of Digital Data and six Working Groups has developed specifications covering all details of the Chart Content and Display Aspects of ECDIS and the Exchange Standard for Digital Data. The IEC has developed Operational and Performance Requirements, Methods of Testing and Required Test Results. These specifications are published respectively, in IHO Publications S-52 and S-57 and IEC Publication 1174.

The IMO is a regulatory agency using international Conventions, regulations and other legal instruments to enforce its will on its Member States in the general interest of the safety of navigation. IHO is a consultative, rather than regulatory body, but through the linkage of the IHO and IEC specifications to the IMO Performance Standards, both these organizations have a certain control over the design and use of ECDIS. It is therefore essential that the complementary specifications are completed before national Administrations may include carriage requirements for ECDIS in their own national maritime regulations.

During the development of the Performance Standards, the IHO specifications underwent a continuous evolution, as more detailed studies were carried out and more experience was gained with earlier forms of electronic charts. Several editions of each publication were produced. It is now hoped that the pace of the developments has slowed and the specifications have reached some maturity and stability. The most critical of these has been the data exchange standard S-57, because the Performance Standard states that the Electronic Navigational Chart (ENC) means the database, standardized as to content, structure and format, issued for use with ECDIS on the authority of government authorized hydrographic offices. (Performance Standard, paragraph 2.12). IHO publication S-52 states that ENC data should be delivered using the IHO Transfer Standard for Digital Hydrographic Data S-57. (S-52 paragraph 3.1) This means that this IHO standard must be finalized and stabilized, an exercise which is happening at this moment. The Digital Exchange Standard S-57 is now in its Version 2.0, but following some comments by users and other remarks on its use, it is now being produced in Edition 3.0. This edition will be accompanied by an ENC Product Specification. The latter being found necessary in order to ensure uniformity in the data provided from different Hydrographic Offices. In order to reduce the data volume it is also being modified to allow data to be exchanged and delivered in a compressed form. It is planned that S-57 Edition 3.0 will be released in April 1996. It will then be subject to an evaluation period or beta testing for six months, before its final and complete release later in the year. Following that, in order to give some stability to manufacturers and data producers it will remain unchanged for a period of four years.

Several other specifications of the IHO are also reaching a point of some stability. Foremost of these are the specifications for Colours and Symbols to be used in ECDIS displays. Although the original idea was that the chart displayed on ECDIS should closely resemble the paper chart it was found that changes had to be made. These included the fact that a projected ECDIS chart on the darkened ship's bridge at night would interfere with the navigator's night vision and consequently different levels of light were needed to suit different ambient light conditions. Also considered was the fact that a properly designed ECDIS, with an object oriented database, could be used in an interrogative way, permitting a simplification of the detailed symbols used on paper charts. This helped to minimize the cartographic

clutter which might have otherwise developed on the electronic chart. It was found in research by perception psychologists that great attention had to be given to defining the colours. As artists know only too well, certain colours placed alongside each other are clearly distinguishable, while others are not. This knowledge may be placed in terms of precise mathematical knowledge and the colours defined in terms of their coordinates, with the system of the Commission Internationale de l'Eclairage (CIE) being advocated. Yet another matter that needed consideration was the fact that the cathode tubes themselves needed to be calibrated to ensure that the correct colours were shown. In order that the colours and symbols to be displayed are related directly to the objects and attributes included in the database a Presentation Library has been produced. However as this is linked to S-57 it is necessary to ensure that the edition of the Presentation Library and hence the Colours and Symbols specified, are related to the latest version of S-57. Therefore one final task, once Edition 3.0 of S-57 is finalized, will be to produce a final edition of the Presentation Library. This work will go ahead during 1996 in order that it may be released as soon after the final release of S-57 as possible.

Two other details of S-52 are moving at a slower pace but there is urgency for their completion. These include specifications for updating the database. At present only guidelines have been published, as the exact direction that updating will take is not sure. During 1995 and into 1996 several trials on updating have taken place. The most notable of these being the BANET project on a ferry in the North Sea, during which it was shown possible to update the data carried aboard a ship at sea through mobile telephone communication. It is speculated that the INMARSAT system may provide a medium for this purpose but several alternative approaches are being examined. With data about to be produced soon on a worldwide level it is necessary to resolve the choice of this technology very soon. Another element of the specifications still to be completed is the means to define data quality. All producers of digital data are faced with this problem and today there is much research in this direction. For paper charts the IHO has advocated the use of source or reliability diagrams to provide chart users with explicit details of the quality of the information on which they are making their navigational decisions. There exists a similar requirement for the navigator using ECDIS. All data being captured and loaded into the database should ideally be tagged with some metadata that defines its quality. The output of this information to the navigator should also be explicit and presented in simple terms. These matters are now being examined by several working groups. As the hydrographic community is on the verge of large scale data capture there is also an urgency to complete these specifications, as it is expected that an addition of data quality parameters at a later stage may be costly.

The IHO is not the only organization with some specifications still to be completed. The IEC also has work to do to complete its specifications in IEC 1174. However certain of this work requires the provision by the IHO of a test data set in the latest edition of S-57. As this has yet to be completed in the latest edition of the IHO Standard, the completion of the IEC specifications present a conundrum! IEC nevertheless predicts that it will complete IEC 1174 in mid 1996, although its official release in a multilingual form may not occur until 1997. In summarizing the position of the completion of all the complementary specifications to the IMO Performance Standards it is to be expected that they will all come together during the latter part of 1996. While manufacturers may express dismay at the slowness of its development the total package has involved much complex work. It appears that

several systems have been developed and in fact are on the market that have 'near ECDIS' characteristics and that any changes required to meet the final specifications are hopefully minor. Manufacturers opinions have been actively sought during the developments. Nevertheless there have been those who want more sophistication and those who want less and treading the path between has been bound not to please all.

THE PROVISION OF DATA

Specifications for the data that may be used by ECDIS have already been discussed. The IHO and its Member States, although initially slow to develop digital data, are now adamant in insisting on the quality of data. It must be authorized by a government Hydrographic Office and it must be delivered in the S-57 standard. Unfortunately the development of the standard has taken time and Hydrographic Offices have not, until recently, been able to divert their priorities from paper chart production and maintenance to digital data. With these delays, commercial companies, which have been developing electronic charts over nearly a decade, have had to look elsewhere for data. The result has been the development of a commercial industry developing digital data by digitizing the paper charts compiled and published by Hydrographic Offices. Although both the systems and the data have improved immeasurably the quality of the data is still reported to be of variable and in some cases, questionable quality. Nevertheless those navigators who have been introduced to electronic charts have been so impressed by their capabilities that they have been prepared to use the commercial data, regardless of its unknown quality.

Several Hydrographic Offices have started producing digital data for ECDIS using earlier editions of S-57 or in national formats that may be easily converted to S 57. Foremost amongst the data producers are Norway, Canada, France and Japan. The desirability of integrating data to provide data bases with global or regional cover has been recognized. In 1991 Norway proposed developing a worldwide digital data base for ECDIS but after consideration by other Member States of the IHO it was decided that a regional approach was more acceptable. These discussions led to proposals for a committee to be formed to discuss the administrative, financial and legal aspects of developing a world wide data base. In 1992, during the XIVth International Hydrographic Conference it was agreed to form this committee, known as the WEND (Worldwide Electronic Navigational Chart Committee). The Committee developed a set of principles and a Conceptual Model for an organization to produce a worldwide database. This model has been described by the author in another paper but consists of several regional electronic navigational chart coordinating centres, known as RENCs. Individual HOs, although retaining the rights to supply digital data directly to national shipping, would as a service to international shipping, provide the data and subsequent updates to the RENC in their regional area. The RENCs would then be responsible for integrating the individual HOs' data and subsequent updates and providing a service to international shipping. Although the details have yet to be worked out it is conceptualized that the RENCs will communicate with one another in order that a

customer may obtain data for any globe circling voyage from the RENC that is most convenient to him.

Although the Norwegian proposal to provide a worldwide data base was not accepted by the IHO Member States, Norway was invited to form a regional coordinating centre that would develop a database for Northern Europe. This Electronic Chart Coordinating Centre (ECC) has been formed and is located at Stavanger, Norway. Recently the UKHO has joined forces with the Norwegians in the operation of this centre. Considerable attention has been given to setting up the arrangements between the ECC and the neighbouring European HOs that are participating in the development. Essentially this results in a series of bilateral agreements between the ECC and each HO, which spell out the technical, financial and legal arrangements. It should be stressed at this time, that the objective in each case is for individual HOs to provide the data, ideally in S-57 digital form but acceptable as rastered data or even paper charts, and subsequent updates and for the ECC to convert all to S-57 format, then to integrate and distribute the data and to return the revenues, less overhead costs, to the originating HOs. When paper charts are used as a source, it is recommended that ideally these be INTERNATIONAL charts. In the particular case of the Northern European RENC it has been also necessary for Norway and UK to define precisely the terms of their joint management. At present the RENC is embarked on data capture and resolving outstanding matters of data updating. It is projected that a database covering the North Sea, the Baltic Sea and English Channel will be available in 1997.

Several other HOs have proposed setting up RENCs. Of these Japan is the most advanced. It has set up the necessary systems and has been actively capturing data in the waters surrounding Japan. This data has been captured in Version 2.0 of S 57 and at some time in the future it must be converted into Edition 3.0. There is also another technical matter to resolve concerning the uniformity of the horizontal reference datum. The IHO has resolved to use WGS 84 as a horizontal reference for all charts and this has now been resolved as being the reference for digital charts. Japan has found it difficult to adhere to this standard due to its national law that requires that all survey data be referenced to Tokyo datum. Administratively Japan has set out to educate its neighbours in the development of electronic chart data by holding a series of seminars. It is not clear at present how it proposes to integrate data as a regional data base. Some indication has been given that it considers that each HO should develop and distribute data for its own coastal area (within an area covered by charts at scale 1:500,000). This would seem to mean that international shipping in East Asia would have to acquire digital data and the associated digital updates from each country it visits on its voyages. This would negate one of the major advantages of not only the WEND concept but also the INTERNATIONAL paper chart system. It is to be hoped that once the administrative mechanism of the Northern European RENC is fully developed its advantages will become apparent and it will serve as the model for other RENCs. Areas where some nuclei of RENC organizations appear to exist are shown in Figure 1.

Another HO that has proposed establishing a RENC is Italy. Over a year ago it proposed to form one with France and Spain for the Western Mediterranean. However this proposal now seems in question. Italy itself has been capturing data making use of a partnership with the Italian commercial firm C-Map but studies have

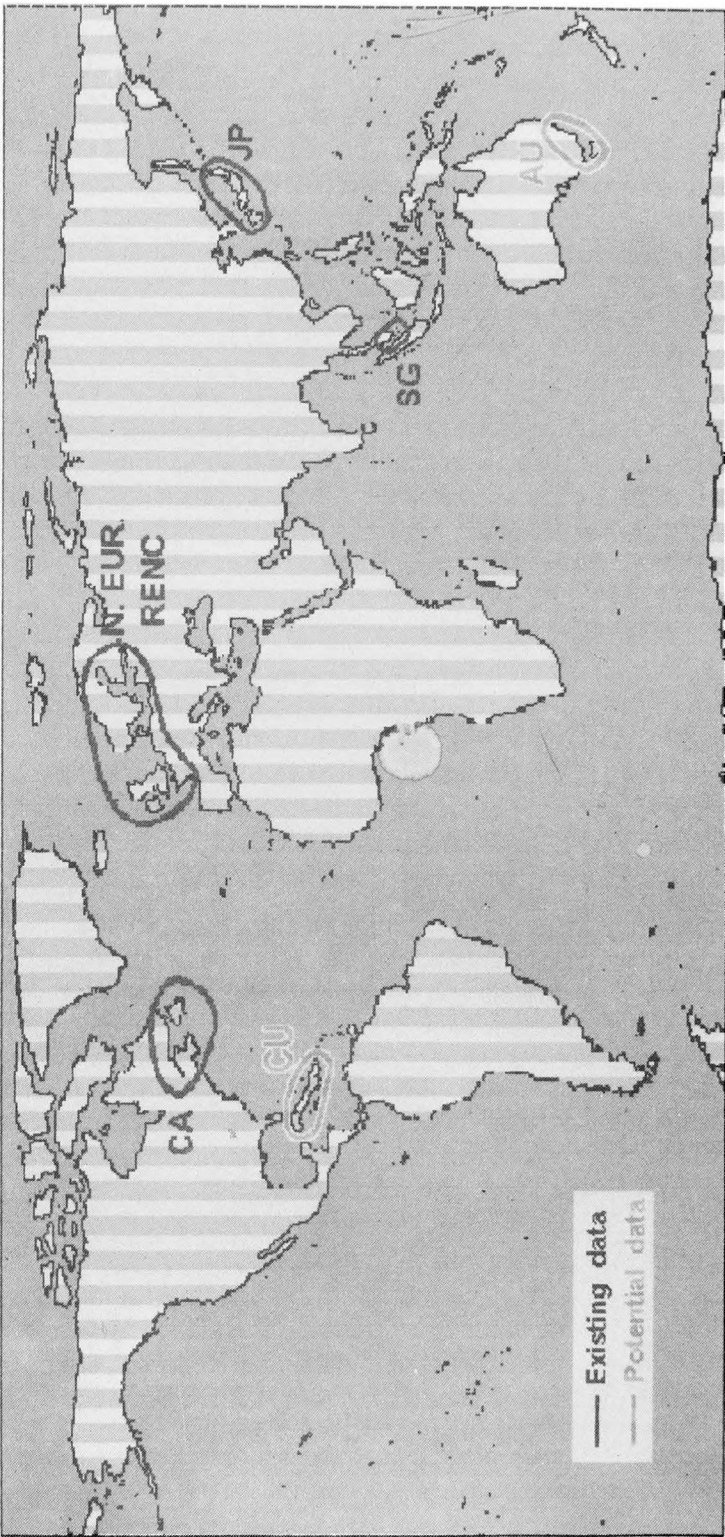


FIG. 1.- RENC NUCII (1996).

now shown that the establishment of a RENC may be unacceptably costly. In addition to this, studies by the European Commission's COST 326 Committee, that has been set up to study ECDIS matters for Europe, has presented arguments that it may be better to have only one RENC covering all European waters, including those of the Mediterranean Sea. If this materializes it would probably take the form of extending the Northern European RENC, capitalizing on its considerable experience and knowledge.

Elsewhere, various countries, including India and South Africa have informally proposed that they establish RENCs but considerable uncertainty exists as to how this will materialize. Based on the Northern European experience it is clear that the formation of a RENC requires considerable investment and that a smaller number of RENCs may be more cost effective than numerous RENCs, although the latter may have more political appeal.

A region for which the future is unclear is the Americas. Canada has taken a very strong lead in the development of expertise and data services for ECDIS users. The USA has two separate activities to consider. Its Defense Mapping Agency (DMA) has decided to use the Vector Product Format (VPF) for its database to satisfy its military requirements. Unfortunately this is not the standard that has been approved by the IHO and consequently data captured by the DMA cannot at present contribute to the WEND. Work is going on to try to harmonize the differences between the two standards but whether this will result in the automatic translation of data from one standard to the other remains unknown. In the National Ocean Service of the USA a strong early lead in ECDIS data development has been seriously set back by political changes in the country. It is reported that at present there is no work going on in developing data meeting S-57 standards. Such work that is going on is either directed at developing raster data or a significantly reduced set of vector data. Although the overall future of a worldwide database and the associated services for S-57 data may still be uncertain, this is the direction in which the IHO is heading and it is most desirable that the USA pick up once again, its activities in that direction. In the Caribbean, Cuba has stated its plans to develop a RENC and is receiving technical assistance from Canada. In spite of budgetary limitations it has already demonstrated considerable skill in developing raster data and has now voiced its determination to develop S-57 vector data and to form a RENC for the Caribbean region. Finally, in South America, where Chile voiced some of the earlier proposals for regional coordination, there are several areas where national development have been reported, but as yet no moves to form a RENC have been reported. From all these activities in North, South and Central America, one is left to wonder how coordination and cooperation will eventually develop.

Moving back to Asia and Australasia, there are national developments going on in Singapore, Indonesia and Australia, which can be expected to interact at some time in the future. Singapore, with its well established high level of cartographic technology, has embarked on a project to develop S-57 data for all its own waters and some adjacent areas. With considerable urbanization and large scale charts to consider it is faced with some major challenges. Although the Hydrographer in Indonesia has not announced any particular plans for ECDIS data development, a major contract has recently been let with a Norwegian company for surveying and charting Indonesian waters. Output from these surveys is to be in digital form in S-57 data. As the Norwegian company will include expertise that is

already used in the North European RENC, we can expect a rapid output of high quality digital data. Australia has developed significant expertise and capability in all aspects of ECDIS and digital data. It has produced trial data sets for the major ports of Sydney and Melbourne. Data production on a continuous and systematic basis has yet to start but it is understood that plans are being made to develop digital data for all Australian waters during the next few years. Exactly how the various national initiatives in East Asia and Australasia will link together regionally is not known at this time. One could speculate on various scenarios with Singapore data being integrated eventually with data from countries to the north or with Indonesia. Likewise one can speculate on an extension of Australian activities towards New Zealand or towards Indonesia.

If the hypothesis is correct that international shipping prefers to obtain data and services from just a few centres rather than from each national HO, there will be a need to consider serving the needs of shipping along their main routes. In the case of East Asia and Australasia this would mean serving the ships on their main routes through the Straits of Malacca and up to Japan and from Australia up through Indonesian and Philippine waters to Japan. Figure 2 provides a speculation from the knowledge available to date and the view of the author on how worldwide scenario of RENCs may appear at the end of the century.

A SCENARIO FOR WEND

The way in which the WEND will eventually develop is uncertain at present. However it is becoming increasingly clear that a market for quality data meeting the IHO S-57 standard does exist. Some uncertainty is introduced by the effect that the availability of raster data, notably the UKHO's ARCS and the USA DMA's data will have on the market. The majority of HOs, including the UK, see raster data that is produced under the authority of HOs, as a useful product that will mainly serve in the interim when S-57 data is not available and for some situations where the higher functional capabilities of ECDIS using S-57 data are not required. Provided that DMA's VPF data is used only to satisfy its military needs it should not confuse the market and the need for S-57 data but should it be released to commercial shipping it will compete with S-57 data and cause some disturbance to the S-57 data market. A further uncertainty is the availability of commercial data. While S-57 data is not available the market will be served from these sources. Whether the availability of HO authorized raster data will cause a transfer of loyalty remains to be seen but the availability of HO authorized S-57 data, with accompanying well organized updating services should result in the demise of commercial data, at least for the larger commercial shipping market.

The concept of a WEND organization based on RENCs is designed to achieve what the IHO has attempted to achieve in its system of INTERNATIONAL paper charts. It is designed to provide the best service to international shipping at the lowest possible cost to the hydrographic community.

To achieve this it has been recommended that overlapping data sets be avoided while at the same time a Member State has the responsibility for the

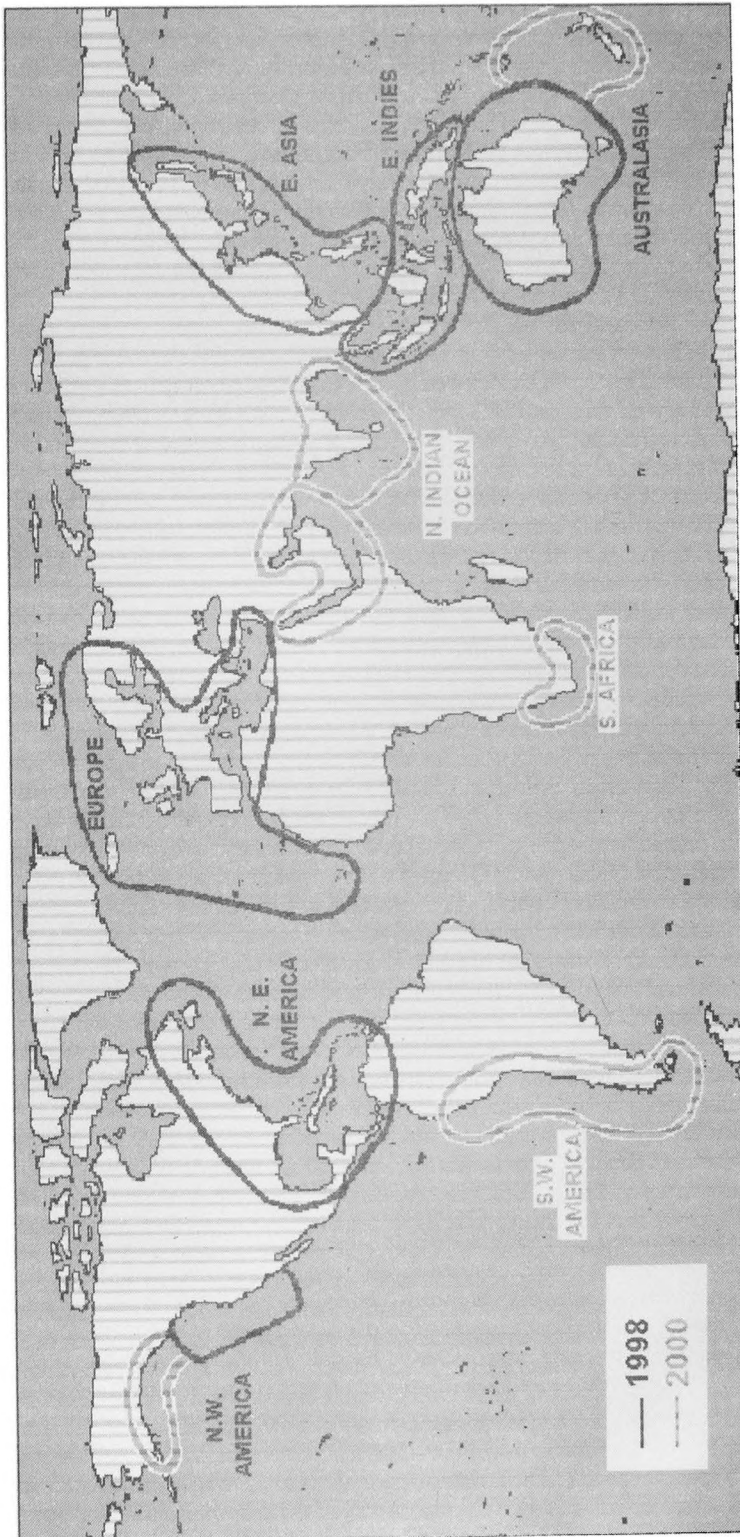


FIG. 2.- Developing RENCS (2000). Some speculation.

preparation and provision of digital data and subsequent updating for waters of national jurisdiction. The idea is that the Member States should contribute to a common resource, receiving for their work in proportion to what they contribute.

The original concept of the WEND organizational structure was based on regional adjacency. This concept is the basis for all the IHO regional structures. The approach is at its best when the participants surround a body of the sea in which they all have interests for reasons of transportation, fishing or oil and gas exploration. Although the approach seems suitable for the North European RENC in which it dealt with the North Sea, the Baltic Sea and the English Channel, it needs to be examined for application elsewhere. Due to the cohesive nature of Europe the extension of the region into the Mediterranean may work well but for a region such as the Americas, where the adjacency is primarily only with the immediate neighbouring country, the reasons for a regional structure may be less supportable. However against this we may recognize that modern data communication has no boundaries and in the servicing of a database the need to consider adjacency may be less important than the need to service the customers or perhaps the language of work. Since the customer is developing a worldwide digital database primarily for international shipping, a essential requirement will be how best to serve it. In the era of paper charts it was necessary to have agents at all major ports of call in order to provide ships with new editions and Notices to Mariners. In a digital world with modern communications it is necessary to ask if that is necessary. The way in which the INMARSAT system deals with Search and Rescue operations provides a model for study. Although there are four satellites covering overlapping bands of the world it is possible for a SAR centre at one side of the globe to deal with the communications involved in a rescue operation on the opposite side. While these things are today technically possible the day to day communications of developing and maintaining a complex database may still require regional adjacency. Added to this is the political reality that communications will normally be better, at least there will be better understanding, between culturally similar neighbours. Although language differences are not insurmountable and although there is a worldwide move to use English as the language of maritime communication, it is clear that there is some advantage in grouping according to a language base.

On consideration of the above issues it will be necessary for the international hydrographic community to consider the best organizational structure for a WEND. It must be hoped that the concept of shared work and shared data will be accepted. It must also be hoped that individual sovereign interests do not overwhelm international cooperation. If the overall view of cooperation is shared it will be necessary to decide upon the distribution of RENCs. Although there are clear indications of the structure for parts of the world there are extremely important shipping routes for which the approach to acquiring data and developing a database is not yet clear. Foremost amongst these is the Persian Gulf and Red Sea. The COST 326 has proposed in one of its working papers that this area be an extension of the European database but this should be discussed by the WEND Committee. For paper charts these areas are served by the world charting agencies. It needs to be decided whether this will continue in a digital world or whether a RENC that is regionally situated is needed to service those areas.

Part of the WEND organization that has been shown conceptually but has not been worked out in detail is the relationship between RENCs. The original desire

was that the RENCs would communicate freely so that data and services for any part of the world could be obtained from another part. Essentially, each RENC would have a total copy of all the other RENC holdings. How practical will that be ? While it may be possible for the basic data, will it also be possible for regular updating services ? The development of communication systems leads one to believe that such free transfer of data is possible. Associated with these ideas is the matter of whether a RENC can be associated with an HO developing data for a terminal point of a trading route. For example, ships being served by the North European RENC may be on regular voyages to Singapore and on the assumptions that the North European RENC will extend into the Mediterranean and that some services will be provided for the Red Sea, the vessels will need data to navigate through the Malacca Straits and arrive at Singapore. This is typical of the future conceptualization that will be required in order to decide on the most suitable organization for WEND.

A matter that has been raised is the availability of data for naval use. HOs that have to date served their naval fleets will be interested in their access to the RENCs. As these are being set up on commercial lines there will be a question of whether the data will be available to navies at no cost. This is a matter yet for discussion by the WEND committee but it is difficult to see how individual HOs, contributing to a RENC, will be prepared to have their data made available to foreign navies with no financial return to them. Navies will also want to ensure that data is immediately available to them and not denied them in times of hostilities. This situation could be taken care of by an arrangement through which they are continually provided with an updated copy of the data from all RENCs, on the provision that they only duplicated it in the event of hostilities.

CONCLUSIONS

ECDIS is arriving perhaps sooner than some people would have originally believed. While the development of standards for the systems and for the data presented major challenges to both the IMO and IHO, the development of a Worldwide Electronic Navigational Chart Database is at present the major challenge facing HOs and the IHO. The WEND organization presents an organizational model that can be used for this purpose but its development requires Member States to realign their priorities and above all else to place international cooperation high on their list of priorities. If HOs do not actively contribute data or worse still, fail to reach agreement amongst themselves on how to provide functional data services in a reasonably short time frame, it is clear that the provision of data for electronic charts will pass to commercial interests. This is a case where nationalism may need to be muted in the interest of providing the best chart services in the interest of the safety of navigation.